PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide a short-circuit and protective device coordination study for the electrical distribution system. The intent of these studies are to verify that the specified and supplied equipment are properly rated, correctly applied, and within industry and manufacturer's tolerances.

B. The short circuit study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the distribution system down to the smallest protective device. The short circuit study shall consider operation during normal conditions, alternate operations, emergency power conditions, and any other operations which could result in maximum fault conditions.

C. The coordination study will determine the correct settings for the protective devices which will minimize the damage caused by an electrical fault and allow for selective coordination between the devices. The coordination study shall include the closest upstream utility protective device down to the panelboard main, branch, or feeder circuit breakers. The coordination study shall consider operation during normal conditions, alternate operation, and during emergency power conditions.

1.2 QUALIFICATIONS

A. The Contractor shall have the coordination study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the state where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.

B. The short circuit and coordination study shall be performed using the SKM PowerTools for Windows computer software package. No substitutions.

C. Pre-approved: PowerStudies, Inc. – Maple Valley, WA.

1.3 SUBMITTALS

A. The contractor shall submit the power system studies within 30 days after the electrical equipment submittals have been received for review by the engineer. The electrical submittals will be reviewed but will not be approved until the power system studies have been received and reviewed.

B. Submit three (3) copies of the power systems study.

PART 2 - EXECUTION

2.1 IMPEDANCE ONE-LINE DIAGRAM

A. The short circuit study shall consider all operating scenarios during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum short circuit current. The following is a list of the known operating scenarios: (Modify for your site or facility)
1. Normal Utility Power
2. Emergency Generator Power

3. Bus Tie Breakers open
4. Bus Tie Breakers closed
5. UPS Power

B. Existing Equipment Data will be provided by the owner Or Existing Equipment Data will be provided by the owner's contractor (_____) who will be invoicing the owner but under the direction of Power Studies.com. Or Existing Equipment Data will be provided by the owner's contractor (_____) who will be invoicing Power Studies.com and will be working under the direction of Power Studies.com. Or Existing Equipment Data will be provided by the PowerStudies,Inc's electrical contractor (_____)and will be working under the direction of Power Studies.com. Power Studies.com will provide Equipment data sheets for the electrical contractor to complete and /or the PSDB electrical equipment database to the electrical contractor to enter data.

C. Power System Equipment Database (PSDB) shall be provided to the owner at the completion of the study. The database shall contain and list all electrical equipment used in the study and the results of the short circuit, protective device study, and arc flash study. This equipment database shall be a Microsoft ACCESS Database. The data base shall have the minimum features and functions:

1. Equipment Nameplate Data and Protective Device Settings for the following equipment shown in the table below. The database shall also have equipment database report listing the data below for each piece of equipment.

ATSs	Control Panels	Disconnect Switches
Circuit Breakers	Fuses	Generators
Motor Control Centers	Motor Starters	Motors > 50 HP
Bus Duct Runs	Panelboards	PDUs
Relays	Switchboards	Switchgear
Transformers	UPS	VSD
Conductor	Other Equipment	Utility Data

The equipment nameplate data shall include a minimum of the following information:

Manufacturer	Type	Voltage
Amperage	kVA	HP
Size (conductor)	Length (conductor)	# per Phase (conductor)
RLA (motor)	LRA (motor)	NEMA Code (motor)
Frame Size	Trip	Sensor
Breaker & Relay Settings	Impedance (generators & transformers)	Winding Connections (Transformers)
Temperature Ratings	Short Circuit Rating	Withstand Rating
Date of Manufacture	Weight (transformers)	Catalog Number
Serial Number		

2. Library with conductor, transformer, fuse, relay, and circuit breaker data.

3. Short Circuit Study results importation from SKM program for all operating scenarios.

4. Arc Flash Study results importation from SKM program for all operating scenarios.

5. The database shall produce the following reports:

Low Voltage Equipment Short Circuit Summary Sheet	Medium Voltage Equipment Short Circuit Summary Sheet	Arc Flash Energy Report (All Scenarios)
Arc Flash Energy Report (Maximum Energy)	Arc Flash Labels (All Scenarios)	Arc Flash Labels (Maximum Energy)
Equipment Nameplate Data and settings Report	Discussion of TCCs Report	Missing Transformer Data Report
Missing Motor Data Report	Missing Conductor Data Report	Missing Connections Report

6. Ability to print Arc Flash labels from the database.

7. Protective Device sizes and settings

8. Time Current Curve report and with comments on each curve.

2.1 IMPEDANCE ONE-LINE DIAGRAM

A. Create an impedance one-line diagram. All electrical equipment wiring to be protected by the overcurrent devices installed under this project and each location where the fault current will be calculated shall be shown. Clearly show, on the one-line, the schematic wiring of the electrical distribution system.

B. Show reference nodes on the one-line diagram referring to a formal report, to include the following specific information:

1. X/R ratios, utility contribution, and short circuit values (asymmetrical and symmetrical) at the bus of the main service, and all downstream equipment containing overcurrent devices.

2. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.

3. Voltage at each bus.

4. Identifications of each bus.

5. Feeder sizes, quantity per phase, and length.

2.2 SHORT CIRCUIT STUDY

A. The study shall be calculated by means of the SKM PowerTools for Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.

B. The study shall be in accordance with applicable ANSI and IEEE Standards.

C. Determine the available 3 phase short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.

D. Present the data determined by the short circuit study in a table format. Include:

1. Node & Device identification.

2. Operating voltage.

3. Type of Protective device. (i.e. fuse, molded case circuit breaker...)

4. Device short circuit rating.

5. Calculated maximum short circuit current, 3 phase or ground fault, asymmetrical and symmetrical, and X/R ratio.

6. De-rate the devices where the tested X/R ratio is less than the calculated X/R ratio. (maximum fault current multiplied by MF.)

7. Comments section indicating that device is underrated.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. The study shall be calculated by means of the SKM PowerTools for Windows computer software package. No substitutions.

B. All requirements of the current National Electrical Code shall be adhered to.

C. The coordination study shall include the closest upstream utility protective device down to the panelboard main, branch, or feeder circuit breakers. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination.

D. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.

E. Graphically illustrate on log-log paper that adequate time separation exists between devices. Sufficient curves shall be used to clearly indicate the coordination achieved between devices. Reasonable coordination intervals and separation of characteristic curves shall be maintained. Plot the specific time-current characteristics of each protective device in such a manner that the upstream devices will be clearly depicted on the sheet.

F. The plots shall include complete titles, representative one-line diagram and legends, associated power company's relays or fuse characteristics, and complete parameters of transformers. There shall be a maximum of eight protective devices per sheet.

G. The following specific information shall also be shown on the coordination curves:

1. Device identifications.

2. Time and current ratio for curves.

3. Fuse, circuit breaker, and relay curves, showing complete operating bands of low-voltage circuit breaker trip curves.

4. Cable damage curves.

5. ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91 and transformer damage curves.

6. Motor starting curves

7. Significant maximum symmetrical or asymmetrical short circuit cutoff point.

8. Electric utility's relays and/or fuses including manufacturer's minimum melt, total clearing, tolerance.

9. Medium voltage equipment relays.

10. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

11. Low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.

12. Pertinent transformer full-load currents at 100 and 600 percent.

13. Ground fault protective device settings.

14. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center and panelboard.

H. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:

1. Device identification.

2. Current transformer ratio, relay tap, time delay, and instantaneous pickup.

3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.

4. Fuse rating and type.

5. Ground fault pickup and time delay

6. Device ID listed on the coordination curves. List coordination curves (sheets) that each device appears on.

PART 3 - ANALYSIS

Analyze the short circuit calculations and highlight any equipment that is determined to be underrated as specified or not coordinated. Propose approaches to effectively protect the underrated equipment.

Proposed major corrective modifications will be taken under advisement by the Engineer, and the Contractor will be given further instructions.

After developing the coordination curves, highlight areas lacking coordination. For each sheet, present a technical evaluation with a discussion of the logical compromises for best coordination.

PART 4 - REPORT

The results of the power system study shall be summarized in a final report. The report shall include the following sections:

A. Introduction, executive summary and recommendations, assumptions, impedance one line drawing, and copies of the project one line drawings.

B. Tabulations of equipment ratings versus calculated short circuit values and X/R ratios, and commentary regarding same.

C. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

D. Copies of the manufacturers time current curves for the devices studied and plotted on the time current curves.